



AN AIRBORNE SIMULATION OF SMAP ACTIVE / PASSIVE MICROWAVE DATA

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Soil moisture is an important component of the Earth's water and energy balance, and is relevant to many applications of societal benefit. In order to retrieve soil moisture accurately from SMAP (Soil Moisture Active Passive) microwave data, prelaunch activities are concentrating on developing improved geophysical retrieval algorithms for each of the SMAP baseline products. The Australian SMAPEX field campaign used an airborne SMAP instrument simulator (PLMR & PLIS) to generate microwave radiometer and radar data at SMAP's 2-3 day temporal repeat and upscaled to SMAP's 3 km and 36 km spatial scale. These data were then used to retrieve soil moisture and compared against observed soil moisture to assess algorithm performance.

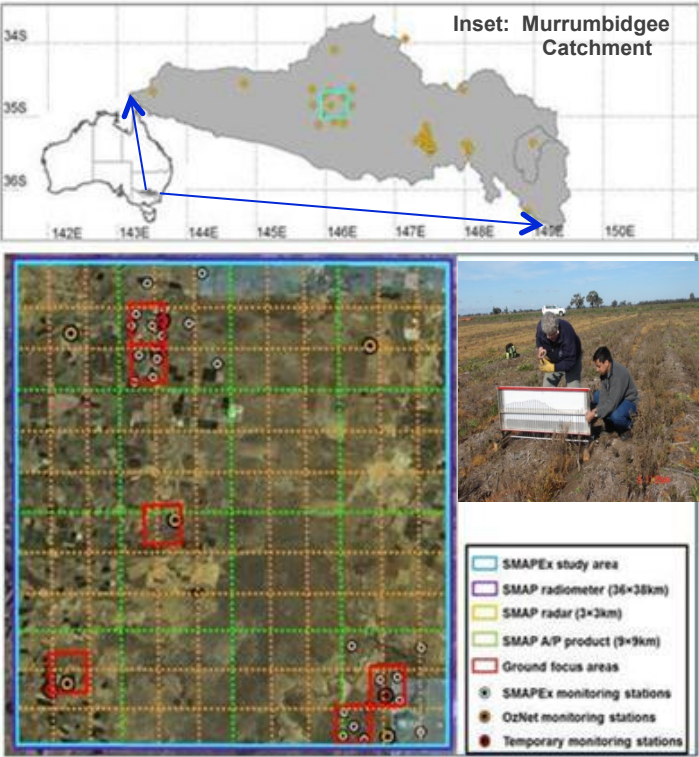


Figure 1. SMAPEX test site near Yanco, New South Wales, Australia, showing nested 3, 9, and 36 km pixels.

Preliminary SMAPEX-1 Results:

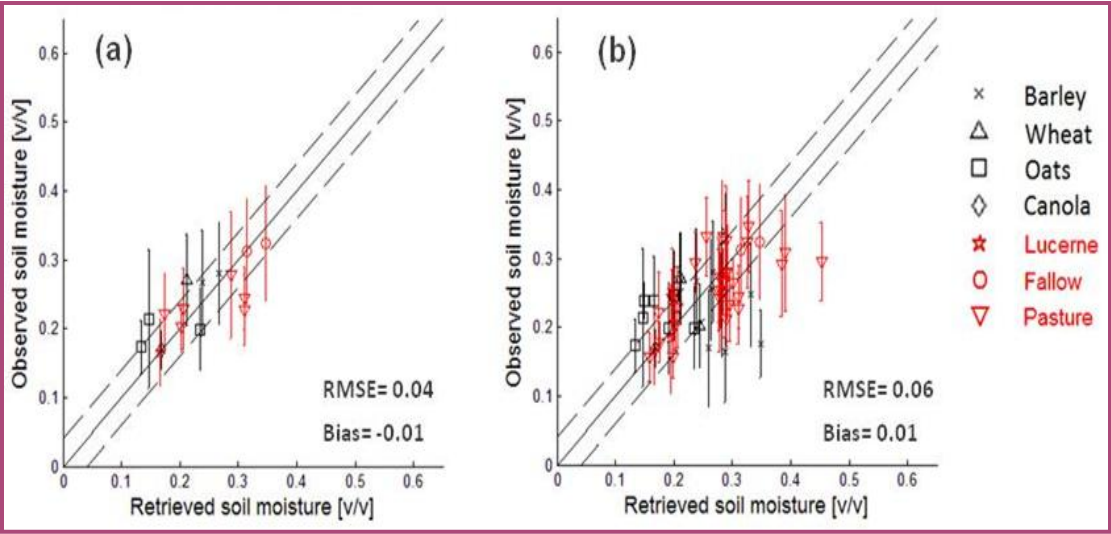


Figure 2. Soil moisture retrieved using L-MEB with a calibrated vegetation b parameter: (a) shows only pixels with measured ancillary data; (b) shows all pixels from the intensive monitoring areas.



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References:

National Research Council, "Earth Science and Applications from Space: National Imperatives for the Next Decade and Beyond," pp. 400, 2007.

Entekhabi, D., E. Njoku, P. O'Neill, K. Kellogg, plus 19 others, "The Soil Moisture Active Passive (SMAP) Mission," *Proceedings of the IEEE*, Vol. 98, No. 5, May, 2010.

Walker, J., P. O'Neill, X. Wu, Y. Gao, A. Moneris, R. Panciera, T. Jackson, D. Gray, and D. Ryu, "An Airborne Simulation of the SMAP Data Stream," Proc. of IGARSS'12, IEEE, Munich, Germany, July 23-27, 2012.

Data Sources: Once launched in late 2014, NASA's Soil Moisture Active Passive (SMAP) mission will use a combination of a four-channel L-band radiometer and a three-channel L-band radar to provide high resolution global mapping of soil moisture and landscape freeze/thaw state every 2-3 days. These measurements are valuable to improved understanding of the Earth's water, energy, and carbon cycles, and to many applications of societal benefit.

Technical Description of Image: SMAP will be the first mission to provide soil moisture globally at ~9 km spatial resolution with a 2-3 day repeat, by combining L-band radiometer data at ~36 km resolution with L-band radar data at ~3 km resolution. The rationale is that an improved spatial resolution and accuracy can be achieved through the unique combination of high resolution but noisy radar data with the more accurate yet lower resolution data from the radiometer. The SMAPEX field campaign was designed to simulate the expected SMAP data stream (both spatially and temporally) using airborne radar/radiometer simulator flights of an entire SMAP nested pixel (3, 9, and 36 km) over different seasons (1-week period in winter, 1-week period in summer, and a 3-week period in the spring growing season). The site chosen for this study was the Yanco area of the Murrumbidgee Catchment located in New South Wales in southeastern Australia, extensively monitored for soil moisture with *in situ* stations since 2003 (see www.oznet.org.au). The site is characterized by flat topography with grasslands and a mix of irrigated and non-irrigated crops. SMAPEX-1 was conducted in July 2010, SMAPEX-2 in December 2010, and SMAPEX-3 in September 2011. These data will be used to assess SMAP retrieval algorithm performance and are currently being analyzed by the SMAP team.

Scientific significance: In order for soil moisture and freeze/thaw to be retrieved accurately from SMAP microwave data, prelaunch activities are concentrating on developing improved geophysical retrieval algorithms for each of the SMAP baseline products using data from simulations, from existing satellite missions such as SMOS, and from field campaign data, such as the SMAPEX airborne study in Australia discussed here.

Relevance for future science and relationship to Decadal Survey: Soil moisture is a critical control on water and energy cycles, as well as weather, climate, hydrological and agricultural prediction. Field campaigns such as SMAPEX in Australia simulate the spatial and temporal data expected from SMAP, providing valuable data for refining soil moisture retrieval algorithms prelaunch, and also serving as a rehearsal for calibration/validation activities post-launch.



Satellite-based Assessment of Climate Controls on US Burned Area

Douglas Morton & Jim Collatz, Code 618, NASA GSFC

Burned area data from the Global Fire Emissions Database (GFED) and Monitoring Trends in Burn Severity (MTBS) provide consistent, satellite-based information about monthly US fire activity from 1984-2009.

Potential evaporation (PE) was strongly correlated with monthly burned area in major US fire regions.

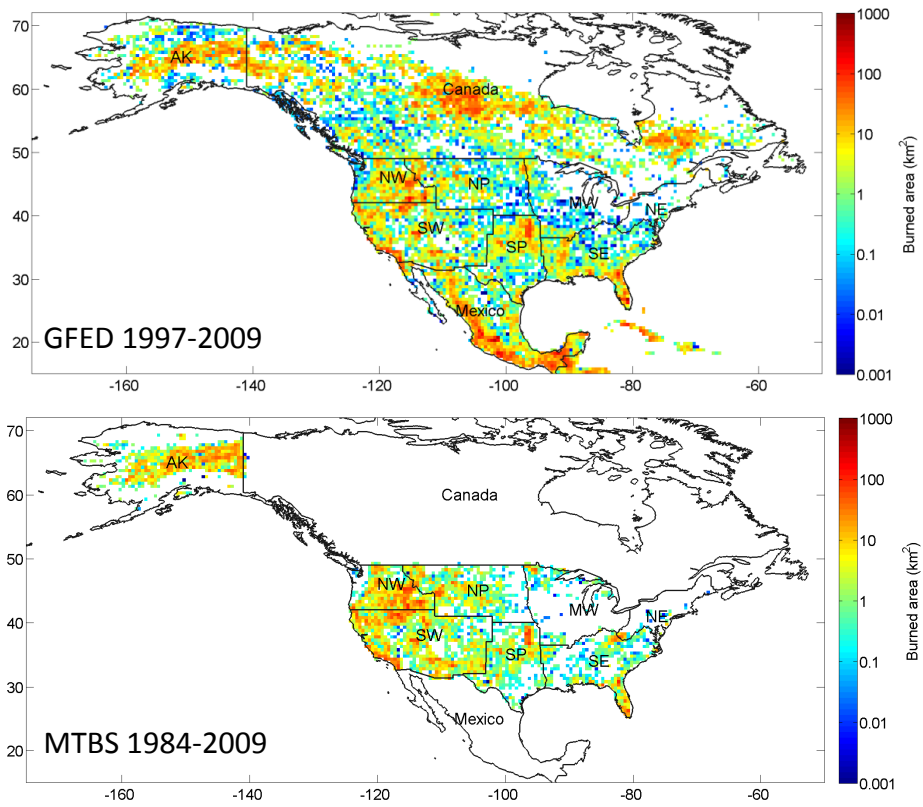


Figure 1. Mean annual GFED burned area (1997-2009, top) and MTBS burned area (1984-2009, bottom). US National Climate Assessment regions are outlined in black.

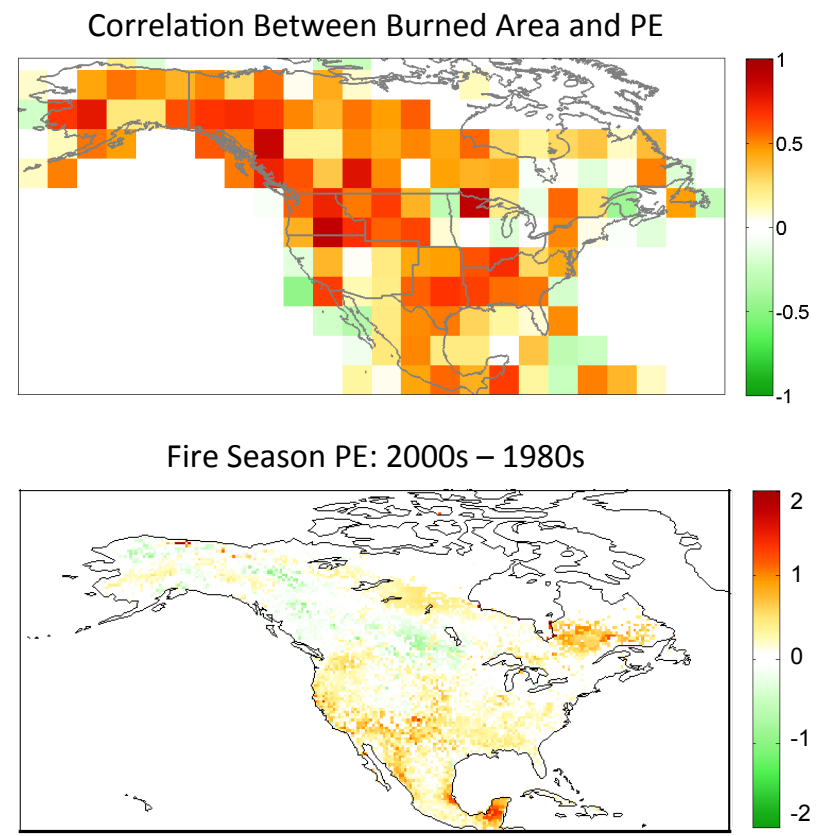


Figure 2. Correlation between burned area and PE (top), and change in PE (mm/day) during the fire season between 1980-2000 (bottom).



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Reference:

• Morton DC, Collatz GJ, Wang D, Randerson JT, Giglio L, Chen Y. Satellite-based Assessment of Climate Controls on US Burned Area. *Biogeosciences Discuss.*, 9, 7853-7892, 2012, doi:10.5194/bgd-9-7853-2012.

Data Sources: This study analyzed the relationships between climate and recent US fire activity at national and sub-national scales. Data on monthly burned area was derived from two satellite-based burned area products. The Global Fire Emissions Database (GFED, www.globalfiredata.org) estimates monthly burned area for six fire types during 1997-2010. Since 2000, >90% of global burned area was mapped using MODIS 500 m data (MCD64A1). Prior to the MODIS era (1997-2000), burned area estimates were based on calibrated relationships between MCD64A1 and active fire detections from the Along-Track-Scanning Radiometer (ATSR) and Tropical Rainfall Measurement Mission (TRMM) Visible and Infrared Scanner (VIRS) sensors. Burned area on state and federally managed lands between 1984-2009 has been mapped by the Monitoring Trends in Burn Severity (www.mtbs.gov) project using pre and post-fire Landsat data. Climate data in this study were derived from the NCEP North American Regional Reanalysis (NARR) dataset at 0.5 degree spatial resolution. Cross correlations were used to assess the strength of relationships between monthly burned area and climate variables for different lead times during and preceding the fire season.

Technical Description of Image:

Figure 1: Mean annual burned area for the US from GFED (1997-2009, top) and MTBS (1984-2009, bottom), shown as the fraction of each 0.5 degree grid cell. Black outlines indicate subnational regions for the 2013 National Climate Assessment: Alaska & Arctic (AK), Northwest (NW), Southwest (SW), Northern Plains (NP), Southern Plains (SP), Midwest (MW), Southeast (SE), and Northeast (NE).

Figure 2: GFED burned area was strongly correlated with potential evaporation (PE) during the fire season (top), defined as the consecutive three month period for each grid cell with the largest fraction of annual burned area. PE was positively correlated with burned area all major US fire regions (SE, SP, NP, NW, & AK) except the SW, where conditions during the fire season are typically hot and dry. Fire season PE (mm/day) increased during the past 30 years (1980-2010) across much of the southern and western US (bottom). Stronger climate controls on fire activity may partially explain the increase in US burned area during this period.

Scientific significance: Contemporary climate-fire relationships provide a blueprint for future changes in US fire activity. Interannual variability in US burned area (BA) was strongly correlated with atmospheric drying potential during the fire season. Fire season PE increased from the 1980s-2000s, enhancing climate-driven fire risk in the SP, NP, NW, and AK where PE-BA correlations were strongest. The US experiences a complex array of fire activity, from small agricultural management fires to large wildfires in the western US and Alaska. Climate-fire relationships within each NCA region were similarly complex; no single climate variable explained more than 60% of the variance in fire season BA. Fire-climate relationships in the SW and SE regions were particularly difficult to generalize, given frequent fire use for agriculture and forest management in these regions. The results of this study illustrate the complex spatial and temporal variability in US climate-fire relationships. However, this complexity, as captured in this study using satellite-based burned area data, could be used to input region-specific relationships between climate and BA to improve the parameterization of models that project future fire activity.

Relevance for future science and relationship to Decadal Survey: Our assessment of climate-fire relationships at regional and sub-regional scales has several direct applications. First, this research provides the first satellite-based national assessment of the climate drivers of forest and non-forest fire activity. Variability in fire-climate relationships within and between regions underscores the importance of ecosystem diversity and management for recent fire activity. Second, detailed understanding of climate-fire relationships provides a means to assess likely changes in regional fire activity from projections of climate change in coming decades. Mid-term climate projections prepared for the IPCC Fifth Assessment Report (AR5) could be used to evaluate fire risk based on the current distribution of ecosystems and fuel loads. Finally, ongoing production of active fire and burned area data from MODIS and VIIRS will extend the time series of fire information for the US and other countries. This analysis could therefore be expanded to include other regions with frequent fire activity.



Detection of Light Outages using the VIIRS Day/Night Band: An Early Case Study on the D.C. Derecho Storm

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The VIIRS (Visible Infrared Imager Radiometer Suite) sensor onboard NASA's Suomi National Polar-orbiting Partnership (NPP) satellite has a new high quality day/night visible band that images the earth and atmosphere at all illumination levels.

VIIRS nighttime calibrated radiances acquired 1-day after the June 30, 2012 D.C. Derecho storm were used to create outdoor light outage maps, using an analytical approach that considers urban area extent, clouds and observation quality.

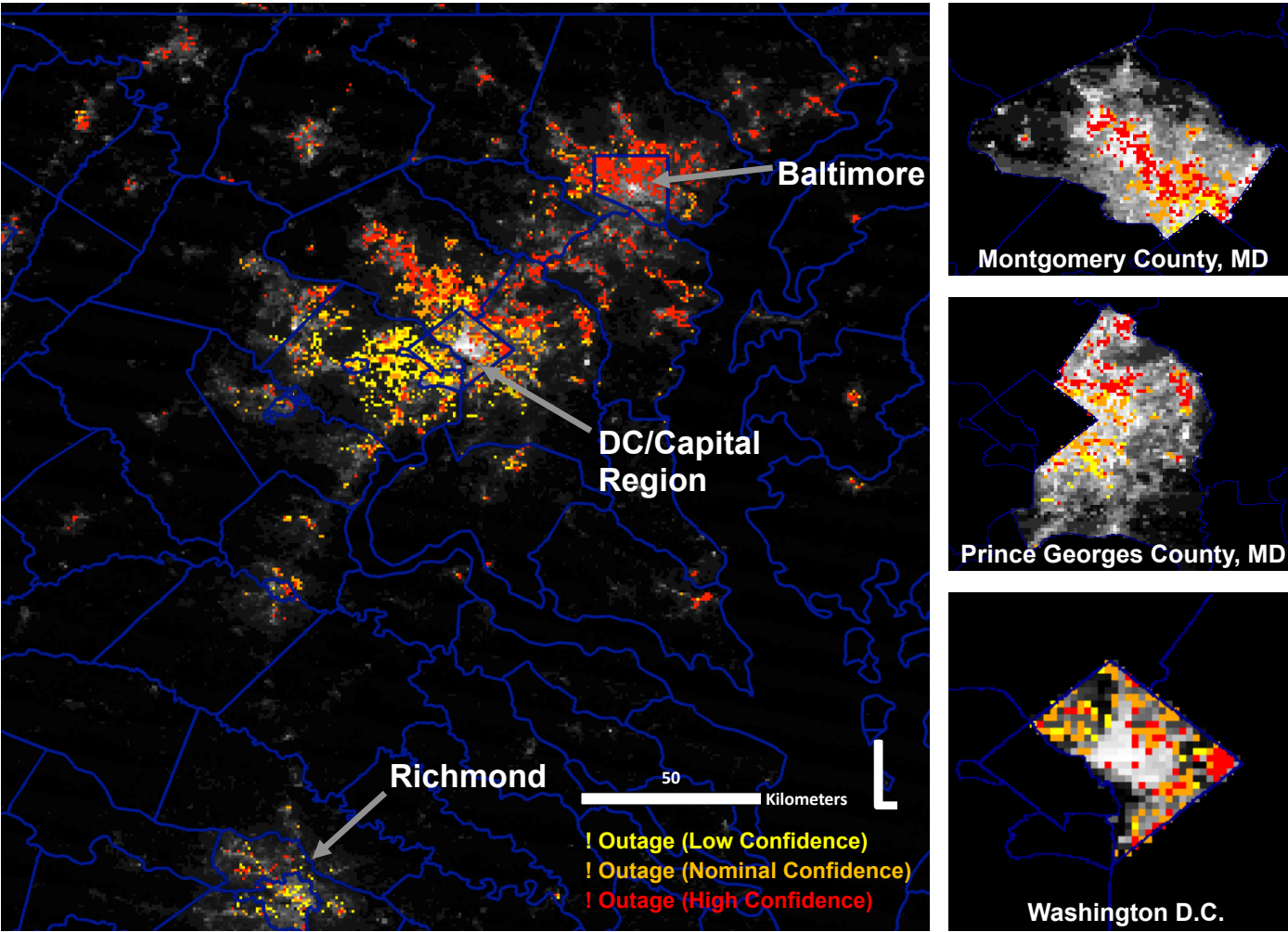


Figure 1: Spatial distribution of light outages in Washington, DC and vicinity after the D.C. Derecho Storm.



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References:

[1] M. O. Román, et al., "Pre-launch evaluation of the NPP VIIRS Land and Cryosphere EDRs to meet NASA's science requirements," *Proceedings of the Geoscience and Remote Sensing Symposium (IGARSS'11)*, Vancouver, BC, pp. 154-157, 24-29 July 2011. doi:10.1109/IGARSS.2011.6048921.

[2] M. O. Román, et al., "Status of the Suomi NPP Visible/Infrared Imager Radiometer Suite's (VIIRS) Land Environmental Data Records (EDRs) after Early Evaluation of On-orbit Performance," *Proceedings of the Geoscience and Remote Sensing Symposium (IGARSS'12)*, Munich, Germany, 24-29 July 2012.

Data Sources: Results of quality assessment of samples of VIIRS nighttime imagery made at the IDPS (Interface Data Processing System) and results of evaluation of improvements to the VIIRS Land Science algorithms, derived by analyzing the products made at Land PEATE (Product Evaluation and Testing Element) using refined algorithms, are placed on the web pages located at the Land PEATE website: http://landweb.nascom.nasa.gov/NPP_QA/.

Technical Description of Images:

(Figure 1) VIIRS nighttime radiances for June 30, 2012 (07:20 UTC) over the Washington DC/Capital region (shown in shades of gray) are superimposed against detections of outdoor light outages (seen in yellow, orange, and red). The light outage product includes for each processed VIIRS nighttime pixel: the relative (%) change in nighttime radiance (e.g., before and after a major storm event), the corresponding uncertainty in the light outage retrieval (based on the variability of the background radiance estimate), and three outage flags (representing the level of confidence that the observation is indeed a "true" outage). The retrieval approach uses urban area extent (based on MODIS Collection V5.1 Land Cover dataset, MOD12Q1), cloud phase flags from the VIIRS operational Cloud Mask, and observation quality (e.g., sensor view-illumination geometry and aerosols) as ancillary data sources.

Scientific significance:

As NASA moves from EOS to Suomi-NPP and into the JPSS era, the wealth of data available from the new VIIRS nighttime observations will provide the foundation for global mapping of human settlements and economic activity at kilometer scales. Expanded use of VIIRS nighttime imagery as a standard NASA product will afford government and emergency management agencies with critical decision support tools for global monitoring and assessment of damage from natural hazards such as hurricanes, tornadoes and earthquakes.